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Dissolving efficacy of different endodontic solvents on gutta percha – An in- vitro study

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Abstract

Background and Objectives: To compare and evaluate the dissolving capability of endodontic solvents like chloroform, xylene and rosemary oil in the removal of gutta percha at different immersion time intervals.

Materials and Method: Total of 120 size #40 gutta percha cones were selected. The cones were pre-weighed on a digital analytical scale. Then they were divided into four groups (n=30) based on the solvents used.

GROUP I- ROSEMARY OIL, GROUP II- CHLOROFORM, GROUP III- XYLENE AND GROUP IV (CONTROL)- DISTILLED WATER. Each group further divided into three subgroups (n=10) based on the immersion time intervals. SUBGROUP A- 02MINUTES, SUBGROUP B- 05MINUTES AND SUBGROUP C- 10MINUTES at room temperature. Samples of different solvents were prepared by taking 5ml of each in a glass vial. The cones were immersed in these solvents at different time intervals and washed in 100ml of distilled water, dried for 24 hours at 37ºC in a humidifier. Post immersion weight was determined. The difference between the original weight of gutta percha and its final weight was calculated. Means and standard deviations of percentage loss of weight were calculated at each time interval for each group of samples. The data was subjected to Kruskal Wallis Test followed by Mann Whitney Post hoc test was used to compare the mean percentage loss of weight b/w groups at different time

intervals. Friedman's test followed by Wilcoxon Signed Rank Post hoc test was used to compare the mean percentage loss of weight b/w different time intervals in each study group.

Results: At 2 minute immersion time intervals, group 2 exhibiting significantly highest mean percentage loss of weight as compared to other groups at P<0.001. This was then followed next with group 3 showing significantly higher mean percentage loss as compared to group 1 & 4 at P<0.001 & finally group 1 with significantly higher mean percentage loss of weight as compared to group 4 at P<0.001. A similar trend was noted at 5 & 10 minute immersion time interval with statistical difference between groups at P<0.001, but the statistical significance between group 2 & 3 was noted at P=0.003 at 5 mins & no significant difference was noted at 10 mins time interval [P=0.44] whereas the remaining differences in the mean weight percentage loss of weight between other groups were similar to 2 mins time interval.

Interpretation &Conclusion: The present study suggests that rosemary oil, chloroform and xylene can be used for dissolving gutta percha. Chloroform being the best solvent compared to xylene and rosemary oil.

Keywords; Endodontics, Gutta percha, Solvents.

Introduction

Various materials are used for obturation of the root canal, among which gutta-percha is most common. One of the disadvantages of it as an obturating material is the lack of an effective seal.[1] However, when the coronal restoration is defective or absent, contamination with saliva may cause root canal sealer dissolution, thus providing a space for bacterial penetration that may contribute to the failure of the treatment.[2]

In the event of failure of endodontic treatment, attempt will be made to re-establish healthy periapical tissues by the way of non-surgical endodontic retreatment. Removal of gutta percha can be done with several techniques, which include rotary files, ultrasonic instruments, and hand files in combination with heat or chemicals.

Solvents have been used in combination with mechanical methods in order to prevent complications like root perforations, canal straightening or altering the original canal shape. Solvents have been used in the past to soften and dissolve gutta percha. However ,all the solvents are known to be toxic to the periapical tissues and should be used with caution.[3,4]

In clinical practice, the most commonly used solvents are chloroform and xylene. In this study, rosemary oil is used as the gutta percha solvent, which is compared with chloroform and xylene.

Materials and Methods

Total of 120 size #40 gutta percha cones were selected. The cones were pre-weighed on a digital analytical scale. Then they were divided into four groups (n=30) based on the solvents used.

GROUP I- ROSEMARY OIL,

GROUP II- CHLOROFORM,

GROUP III- XYLENE

GROUP IV (CONTROL)- DISTILLED WATER.

Each group further divided into three subgroups (n=10) based on the immersion time intervals

SUBGROUP A- 02MINUTES,

SUBGROUP B- 05MINUTES

SUBGROUP C- 10MINUTES at room temperature.

Samples of different solvents were prepared by taking 5ml of each in a glass vial. Immediately after the gutta percha cone was immersed in the solvent, timing was started with a stop watch and the stopper of the bottle was replaced. If the gutta percha sample stuck to the glass vial during testing, it was dislodged with vibrations

on vortex shaker to prevent clumping of partially dissolved gutta percha. The samples were removed from the glass vial after the specified immersion period and washed in 100ml of distilled water, dried for 24 hours at 37ºC in a humidifier. Post immersion weight was determined using digital analytical scale. The extent of gutta percha removed from the specimen was calculated from the difference between the original weight of gutta percha and its final weight using the following equation:

M=M2-M1

Where,

M2=post immersion weight.

M1=pre immersion weight.

Means and standard deviations of percentage loss of weight were calculated at each time interval for each group of specimens.

Result

The mean percentage loss of weight between 4 groups at 2 mins demonstrated a significant difference at P<0.001. Multiple comparison of mean difference between groups showed group 2 exhibiting significantly highest mean percentage loss of weight as compared to other groups at P<0.001. This was then followed next with group 3 showing significantly higher mean percentage loss as compared to group 1 & 4 at P<0.001 & finally group 1 with significantly higher mean percentage loss of weight as compared to group 4 at P<0.001. A similar trend was noted at 5 & 10 mins time interval with statistical difference between groups at P<0.001, but the statistical significance between group 2 & 3 was noted at P=0.003 at 5 mins & no significant difference was noted at 10 mins time interval [P=0.44] whereas the remaining differences in the mean weight percentage loss of weight between other groups were similar to 2 mins time interval.

Figure 1: Mean percentage loss of weight b/w 3 groups at diff. time intervals

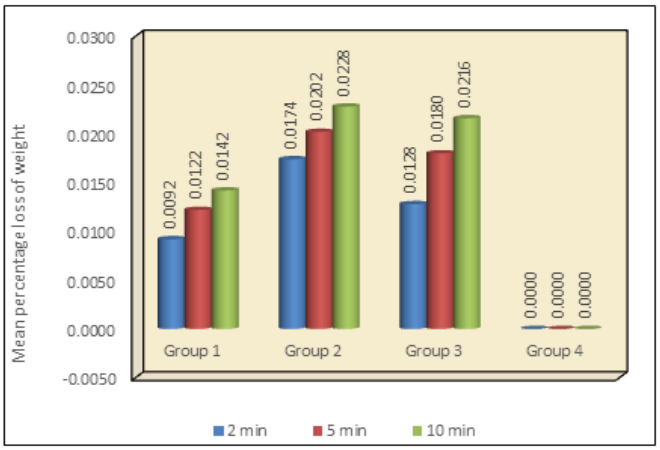

Table 1: Comparison of mean percentage loss of weight b/w diff. time intervals in each group using Friedman's test followed by Wilcoxon Signed Rank Post hoc Test

Groups	Time	N	Mean	SD	P-Value [a]	Sig. Diff	P-Value [b]
Group 1	2 min	10	0.0092	0.0014	<0.001*	2m vs 5m	0.01*
	5 min	10	0.0122	0.0011		2m vs 10m	0.004*
	10 min	10	0.0142	0.0011		5m vs 10m	0.008*
Group 2	2 min	10	0.0174	0.0010	<0.001*	2m vs 5m	0.07
	5 min	10	0.0202	0.0041		2m vs 10m	0.004*
	10 min	10	0.0228	0.0033		5m vs 10m	0.08
Group 3	2 min	10	0.0128	0.0014	<0.001*	2m vs 5m	0.004*
	5 min	10	0.0180	0.0009		2m vs 10m	0.005*
	10 min	10	0.0216	0.0021		5m vs 10m	0.006*

(The level of significance was set at P<0.05, - Significant*)

Discussion

The basic aim of non-surgical endodontic retreatment is to re-establish healthy periapical tissues after inefficient treatment or reinfection of an obturated root canal system because of coronal or apical leakage.

There are several methods for removal of gutta percha during retreatment procedures. The method adopted depends on the initial examination, quality and length of the filling material. When small, underprepared and curved canals need negotiation, solvents and small k-type files are best suited. In many cases combined use of different techniques may be the most efficient and time saving method. [5]

In clinical practice chloroform is the most effective and most widely used solvent for guttapercha ,other solvents include xylene, halothane, tetrachloroethylene.[6] In recent years, natural products containing d- limonene have been investigated because of its safety and effectiveness in removing gutta percha like tangerine oil, grape fruit oil, lemon oil, orange oil etc[7,8,9]. As rosemary oil contains d – limonene oil in its composition, it is used as a gutta percha solvent in the present study.

According to the result of the present study, chloroform was the solvent that showed greatest ability to dissolve gutta-percha. The results of the study are in accordance with previous studies by Gustavo A Rubino et al. [10]

Chloroform is an organic compound with the formula CHCl3 as a polar molecule, but is classified as a non-polar solvent. It is a useful solvent for non-polar molecules or fat. As well as its non-- polar property, within the molecule it shows weak polarity and could potentially break the intermolecular interaction between the polymer chains by penetrating into the chains. As a consequence of the solvation process (chloroform molecules surround the polymer chains), the polymer becomes swollen, viscous, and finally dispersive in the solvent, given the stronger Van der Waals interaction between the solvent and polymer chain. [11]

Since chloroform is strongest and it is quickly effective, its rapid evaporation also makes it a useful chair side material. [4] However, it has been identified as a potential carcinogen. Because of concerns of carcinogenicity of chloroform clinicians and researchers have developed a renewed interest in finding alternative solvent . [12,13,14]

Xylene is an aromatic organic solvent, usually available in the form of di-methyl-benzene. It presents as a univeral solvent of oraganic substances, mainly hydrocarbons, (which comprise the gutta-percha cones in the form of alkadienes), probably due to destabilization of covalent bonds between the carbon atoms.

Muralidhar Tummala et al [15] found that the dissolution of gutta percha in xylene is considered poorer than in chloroform. However, chloroform tends to be messy and inconvenient as it dissolves rather than softens the gutta-percha, leaving residues on the walls of the pulp chamber. xylene on the other hand dissolves the gutta-percha more slowly thus allowing a better control and removal of softened rather than liquified gutta percha.

R officinalis l, popularly known as rosemary, a plant belonging to the family lamiacea and originated from the mediterranean region. Salido et al[16] reported that the chemical composition of rosemary essential oil contains, camphor (17.2-34.7%), a-pinene (10.2-21.6%), Wcineole (12.1-14.4%), camphene (5.2-8.6%), borneol (3.2-7.7%), p-pinene (2.3-7.5%), verbenone (2.2-5.8%), p-caryopliyllene (1.8-5.1%), limonene (2.0-3.8%),a -terpineol(1.2-2.5%),i nyrcene (0.9-4.5%),p -cymene

(0.2-3.4%),bornyl acetate (0.2-2.3%), linalool (0.3-1.0%) and terpinen-4-01 (0.4-0.9%).

Lucas Malvezzi de Macedo et al,[17] reported that rosemary has antifungal, antiviral, antibacterial, anti-inflammatory and anti-oxidant activities. According to Biljana Bozin et al,[18] Rosemary showed a wide range of anti bacterial activity against gram +ve and-ve bacteria. His study recorded a notable susceptibilty of the gram – ve pathogenic bacteria and reported that, all the strains of E-coli, including the multi resistant one, showed high sensitivity to rosemary oil. It contains phenols which have the ability of inhibition on cell wall and cell membrane synthesis and wide range of bacteria and fungi inhibition.

As rosemary oil contains limonene as its component, it is used as gutta-percha solvent in this study. Jeeraphat Janarath et al [9] reported that, Limonene oil is composed of a non polar cyclic molecule and is classified as a non polar solvent. It has similar forces to those holding the polymer chain together. This oil was experimentally observed to be able to penetrate the polymer strands with similar force of chloroform, which held the polymer chain together. This process separates the polymer strands held together so the gutta percha dissolve. However, the effectiveness of solubility was less than chloroform since it is a non polar molecule possessing a weaker dispersion force on vander waals force between the chain polymer.

The dissolving efficacy of these solvents is studied at different time intervals at room temperature to investigate the potential of these solvents for clinical use in dissolving gutta-percha. In relation to the time period, the present study showed that the chloroform exhibited the best solubility in relation to the xylene and rosemary oil at 2 min, 5min and 10 min time intervals and rosemary oil showed the least solubility. And the study results showed that, there was significant increase in the mean percentage loss of weight from 2min to 5min and 10 min for all the solvents except for the control group (distilled water).

Conclusion

Rosemary oil has considerable effects in softening the gutta percha, but its properties have to be improved for clinical use. Further studies are required in order to prove its clinical efficacy. All three solvents showed a better dissolving capacity at 10 minute time interval.

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